Banked Fascia Lata in Sellar Dura Reconstruction after Endoscopic Transsphenoidal Skull Base Surgery

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Abstract

Objectives   Cerebrospinal fluid (CSF) leakage is an undesirable complication of transsphenoidal skull base surgery. The issue of the most appropriate sellar dura repair remains unresolved, although a multilayer technique using autologous fascia lata is widely used. We describe the novel application of a homologous banked fascia lata graft as an alternative to an autologous one in the reconstruction of sellar dura defects in endoscopic transsphenoidal surgery.

Design   The clinical records of patients who underwent endoscopic transsphenoidal surgery at our department from June 2012, when we started using homologous fascia lata, up to July 2014 were reviewed retrospectively. The data concerning diagnosis, reconstruction technique, and surgical outcome were analyzed.

Results   We treated 16 patients successfully with banked fascia lata. Twelve patients presented intraoperative CSF leakage, and four patients were treated for postoperative rhinoliquorrhea. Banked fascia lata was used in a single-to-multilayer technique, depending on the anatomical features of the defect and of the sellar floor. No complications or failures in sella reconstruction occurred.

Conclusion   A banked fascia lata graft proved reliable and safe in providing an effective sellar dura reconstruction. Used in a multilayer strategy, it should be considered a viable alternative to an autologous fascia lata graft.

Keywords
- ► fascia lata
- ► tissue bank
- ► endoscopic transsphenoidal surgery
- ► cerebrospinal fluid leak
- ► sellar dura reconstruction

Introduction

Cerebrospinal fluid (CSF) leakage is a challenging and undesirable complication of endoscopic transsphenoidal skull base surgery. To date no consensus has been reached regarding which material or combination of materials and which technique is the most appropriate for the reconstruction of osteo-dural defects.[1] Over the past few years, several materials—autologous, eterologous, and synthetic—have been proposed in the repair of CSF leaks,[2–6] especially since the wider indication for extended transsphenoidal approaches has focused the attention on this issue.[1,2,7,8] Synthetic materials tend to be used less often. A multilayer technique with autologous fascia lata seems to be the most effective among the free grafts, due to its characteristics of texture and consistency that are similar to dura.[1,4,7] Homologous banked cadaveric fascia lata offers these same advantages, avoiding the complication of autologous harvesting.[9,10] In our preliminary series of 16 patients who underwent

transsphenoidal endoscopic skull base surgery, we present the novel application of banked cadaveric fascia lata used successfully to repair intraoperative or postoperative CSF leaks.

Methods and Materials

Patient Population

We retrospectively reviewed the database of all patients who underwent endoscopic transsphenoidal surgery at our institution from June 2012, when we started using homologous fascia lata grafts for sellar dura reconstruction, up to July 2014. All the data concerning diagnosis, indication for reconstruction, techniques, along with the surgical outcomes, were analyzed (►Table 1). All patients signed an informed consent for surgery and were made aware of the use of homologous tissue.

Banked Fascia Lata

Fascia lata harvesting in the tissue bank at our institution follows the transplantation legislation in force concerning collection, handling, processing, conservation, and distribution of human tissues for clinical use. The surgical procedure of cadaveric fascia lata retrieval follows a strict and certified protocol. The harvesting is performed in a safe environment to preserve the original properties of the tissue. The donor is thoroughly screened for the most important viruses including human immunodeficiency virus (HIV), hepatitis C virus, hepatitis B virus, and cytomegalovirus. After processing, the tissue is frozen at $-160°$C in liquid nitrogen gas. This procedure also decreases the potential for graft rejection due to histocompatibility receptors. A cryoprotectant is used to maintain the integrity of the cell membranes and the vitality of the cells after unfreezing. The tissue is available for clinical use 40 minutes after request.

Operative Technique

All patients were operated on with general anesthesia, in a supine position with the head slightly lifted, by means of a 4-mm, 0-degree lens rigid endoscope. The standard surgical technique proceeded through the usual nasal, sphenoid, and sellar phases. As always during transsphenoidal approaches, particular attention is paid toward an accurate dissection of the anatomical layers, isolating and preserving bone and dural margins. The dural opening is tailored in proportion to the lesion, and care is taken to preserve a portion of the sellar floor to serve as a rigid support for reconstruction after its demucosization. All these factors allow prearranging a watertight reconstruction when necessary.

After the lesion has been removed—or, in the cases of postoperative rhinoliquorrhea, after the sella has been emptied from previous materials—the sellar space is usually packed with an autologous fat patch (►Fig. 1A), harvested from the abdomen through a 2-cm-long incision. Three layers of banked cadaveric fascia lata are usually set up and shaped after the defect in a roughly oval fashion. The fascia lata aspect originally facing muscular tissues is the stickier one, and during reconstruction it is oriented inward. Conversely, the aspect originally facing the subcutaneous tissues is oriented externally toward the sphenoid sinus. The first layer is placed intradurally, with a surface

exceeding the dural defect by 25 to 30% (►Fig. 1B). It is usually rather easy to arrange, provided the intrasellar fat patch is there to keep it in place. The second layer is placed extradurally within the bone margins (►Fig. 2). Different reasons make this layer difficult to set, such as the easy displacement of the intradural layer and the demanding detachment and isolation of the bone margin both laterally toward the cavernous sinuses and superiorly toward the planum-tuberculum or inferiorly toward the clivus. Such maneuvers can be very tricky at times. Consequently, this layer is usually smaller, exceeding the bone defect surface by ~ 15 to 20%, and its complete underlay underneath the bone is not always feasible (►Fig. 3). The third and last fascia layer is extrasellar, placed on the previously demucosized posterior sphenoid sinus wall (►Fig. 4). Fibrin glue is then used as an external overlay in most cases. The same technique is used for both intraoperative CSF leakage and the repair of postoperative CSF fistulas.

Results

A total of 67 consecutive patients underwent endoscopic transsphenoidal surgery during this period. Banked homologous fascia lata was used in 16 patients, 8 females and 8 males, ranging in age from 8 to 73 years (mean: 49.5; median: 48). In 12 cases the endoscopic repair was performed right after the removal of the lesion, given the evidence of CSF leakage. Seven patients underwent surgery for pituitary adenoma (two patients for a recurrence); two patients for an intra-suprasellar craniopharyngioma, one patient was treated for an intrasuprasellar arachnoid cyst, one for an intra-suprasellar germinoma, and one for a clival chordoma. Instead four patients underwent the repair of a postoperative CSF fistula after previous transsphenoidal endoscopic surgery in two cases of pituitary adenomas with significant suprasellar extension, one case of Rathke cleft cyst, and one case of a microadenoma secreting adrenocorticotropic hormone with an empty sella. The endoscopic repair occurred within a time interval ranging from postoperative day 7 to day 32. In all cases, the CSF leak was a grade 2 or 3 according to the grading system presented by Esposito et al.[3]

Surgical Outcome

The reconstruction technique entailed different fascia lata layering, varying from one to three depending on the anatomical features of the defect and of the surrounding structures. In five patients the fascia lata was arranged in a triple-layer fashion (intradural, extradural, and extrasellar) (►Fig. 5). In eight cases two layers were used for reconstruction, and in the remaining three patients a single fascial layer was used. The fascia lata patch was routinely laid in association with autologous abdominal fat graft and fibrin glue in variable combinations (►Table 1). A lumbar CSF diversion was used in a total of nine cases. It was always used in the group of four patients who underwent a postoperative CSF fistula repair and was maintained for an average of 7 days. In the group of patients treated for intraoperative CSF leakage, four cases had the lumbar drain preemptively placed just after the procedure and kept for an average of 7 days; in one case it was inserted in the third postoperative day

**Table 1** Patients' data, reconstruction technique, and follow up

Patient no.	Sex, Age, y	Diagnosis	Time to reoperation, d	ELD	Fascia lata graft			Clinical follow-up, mo	Rhinoscopy follow-up, mo
					ID	ED	ES		
1	F, 68	CSF leak	10	x	x	x		22	9
2	M, 73	Recurrent pituitary adenoma		x	x			20	–
3	F, 65	Pituitary adenoma			x	x		18	–
4	M, 43	Recurrent pituitary adenoma		x	x	x		17	4
5	F, 16	Craniopharyngioma		x	x	x	x	14	8
6	F, 70	Pituitary adenoma			x		x	13	7
7	F, 65	Pituitary adenoma			x	x	x	12	8
8	M, 54	CSF leak	22	x	x	x	x	12	–
9	F, 40	Giant pituitary adenoma				x	x	2[a]	1
10	F, 39	Suprasellar arachnoid cyst		x	x	x	x	6	2
11	M, 45	CSF leak	7	x	x	x	x	5	1
12	M, 41	Clivus chordoma				x		5	2
13	M, 70	Pituitary adenoma			x			4	2
14	M, 51	CSF leak	32	x	x		x	3	2
15	F, 8	Intra-suprasellar germinoma		x	x	x		3	0.5
16	M, 44	Craniopharyngioma			x		x	1	1

Abbreviations: CSF, cerebrospinal fluid; ED, extradural; ELD, external lumbar drainage; ES, extrasellar; F, female; ID, intradural; M, male.
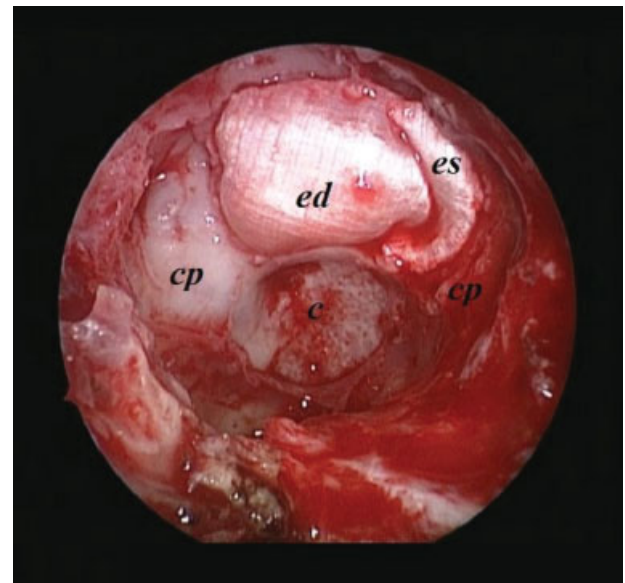[a]Died from a pulmonary thromboembolism.
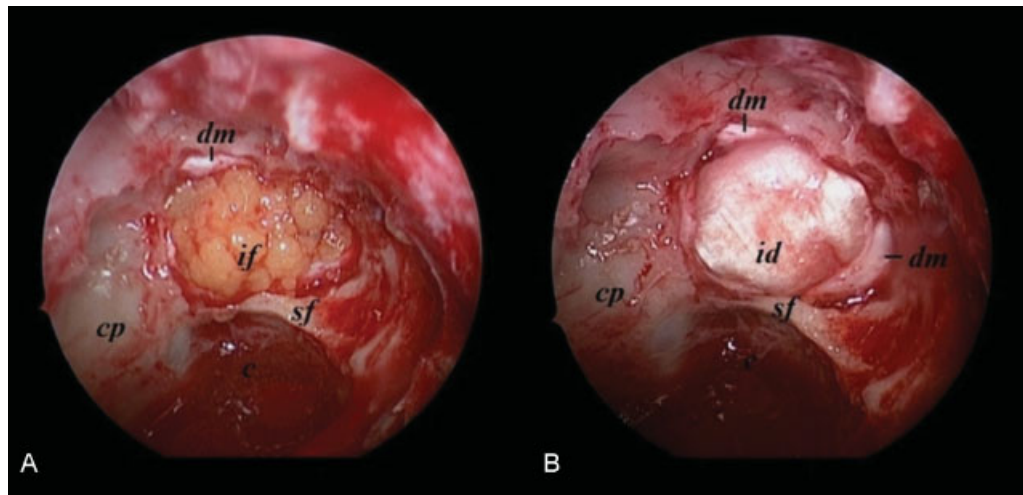
Fig. 1 Endoscopic view. (A) The intrasellar fat patch is in place. (B) View of the intradural homologous fascia lata layer. c, clivus; cp, carotid protuberance; dm, dura mater; id, intradural; if, intradural fat; sf, sellar floor.
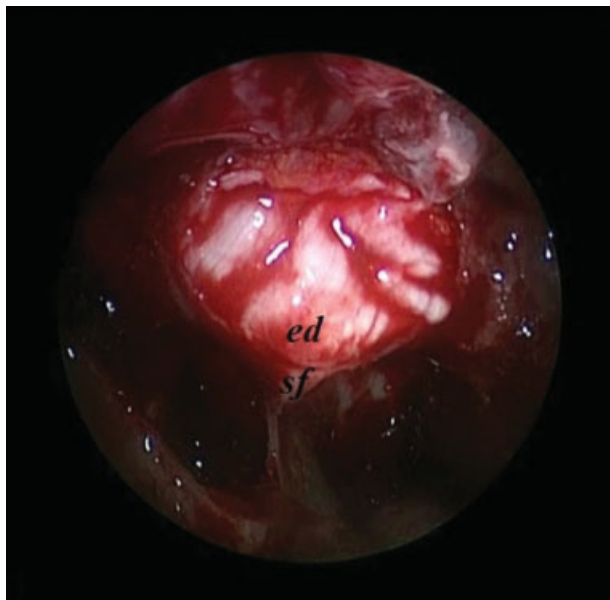
Fig. 2 Endoscopic view of the extradural layer of the homologous fascia lata. ed, extradural; sf, sellar floor.

Fig. 3 The extradural layer is only partially arranged underneath the bone margins. c, clivus; cp, carotid protuberance; ed, extradural; es, extrasellar.

for a dubious CSF leak and maintained for 8 days during which no rhinoliquorrhea was observed.

In all 16 cases there was no evidence or persistence of CSF fistula during the postoperative course or during the follow-up (ranging from 1 to 22 months). Thirteen of the 16 patients underwent regular postoperative endoscopic ear, nose, throat checks, during a variable time interval ranging from 15 days to 9 months (►**Table 1**). Neither CSF leaks nor other complications were noted, and an adequate integration of the homologous material was observed.

Discussion

Standard and extended transsphenoidal approaches to the sella and the anterior cranial base often entail the opening of a large communication channel between the intradural space and the nasal cavity, with the risk of CSF leak and related complications such as meningitis and tension pneumocephalus.[1–3,6,7,11–17] The rationale of sellar dura repair in CSF leakage is to create a watertight-protective barrier. The issue of the most appropriate intraoperative reconstruction of the anterior skull base, as well as of the repair of postoperative CSF fistulas, remains unresolved. This topic has become increasingly important with the wider application of extended endonasal endoscopic surgery.[1,6,13] Numerous reconstruction techniques and materials—autologous, eterologous, and synthetic—have been described.[2–5,8,13,14,18–26] Several authors advocate the use of a pedicled flap, especially in extended approaches.[7,22,27,28] In the decision-making process, the endoscopic surgeon should consider the potential morbidity and technical difficulty of a vascularized flap versus free tissue grafts.[4]
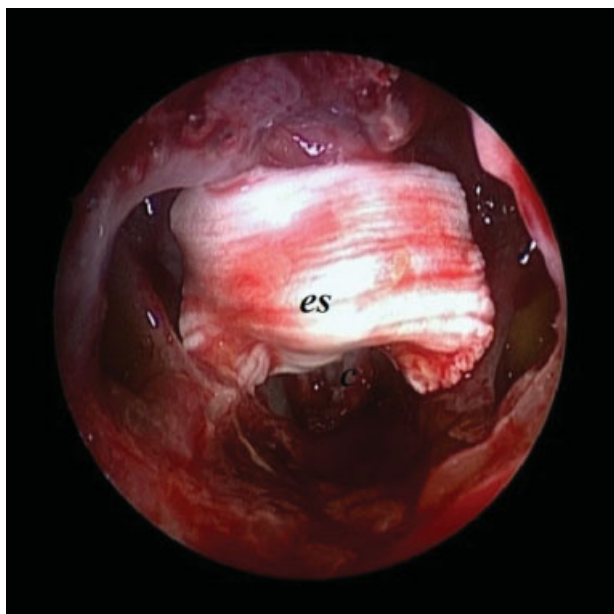
Fig. 4 Endoscopic view of the extrasellar layer completely covering the sellar floor and part of the posterior sphenoidal sinus. c, clivus; es, extrasellar.

According to the literature, the fascia lata seems to be the preferred autologous free grafting material and is most effective when used in a multilayer technique.[1,4,7] It is easy to harvest and large grafts can be obtained, it heals very well, and its texture and consistency are similar to dura.[4] Nevertheless, the procedure of autologous fascia lata harvesting entails a skin incision, exposing the patient to the risk of donor site complications such as infections, hematoma, wound dehiscence, problems with

walking, and the cosmetic appearance of the scar.[10,12,17,29] When harvested from the thigh, autologous fascia lata prolongs the overall surgical time.[29] In light of these reasons, we considered using banked homologous fascia lata. The most established use of banked fascia lata grafts is in orthopedic procedures.[29] Another common application is described for urologic and gynecologic surgery for the treatment of stress urinary incontinence and in ophthalmologic surgery for the treatment of ptosis.[10,29,30] Its novel application in abdominal wall repair was recently reported.[31]

The tissue bank of our hospital is widely renowned, providing service to several hospitals in northern Italy. Cadaveric grafts have been used for several years at our institution, where spinal surgery in particular takes advantage of homologous bone grafts and human pericardium is used as a dural substitute during craniotomies. The use of cadaveric tissues may be of concern because of the potential transmission of infectious diseases, with a risk of HIV transmission estimated as 1 in 8 million cases, and the prion diseases, but the association between prion-related diseases and the use of cadaveric fascia lata is not documented.[29,30] Given the vast and positive experience gained in the use of homologous materials and the results in terms of safety and effectiveness, we applied, for the first time to our knowledge, homologous fascia lata in endoscopic transsphenoidal repair of CSF intraoperative leakages and postoperative CSF fistulas in a series of 16 patients.

From an anatomical point of view, the external aspect of homologous fascia lata (originally interfacing the subcutaneous fat of the thigh) has a smooth surface characterized by dense connective tissue fascicles, unlike the inner aspect (originally interfacing muscular tissue) that appears stickier.
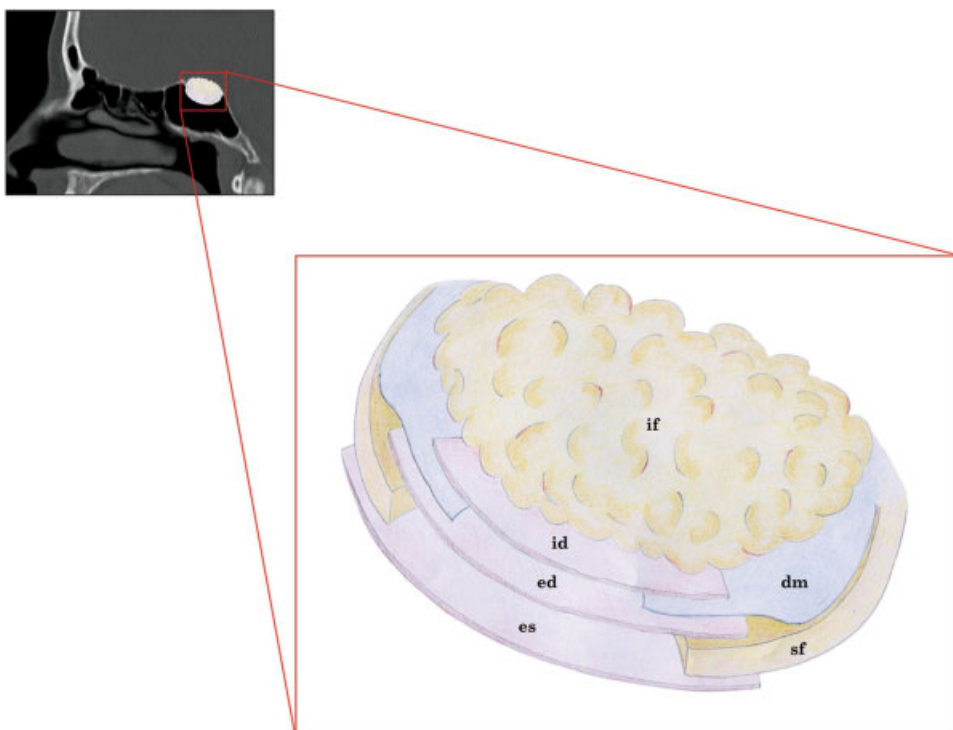
Fig. 5 Schematic drawing showing the three-layer reconstruction technique with homologous fascia lata. dm, dura mater; ed, extradural; es, extrasellar; id, intradural; if, intradural fat; sf, sellar floor.
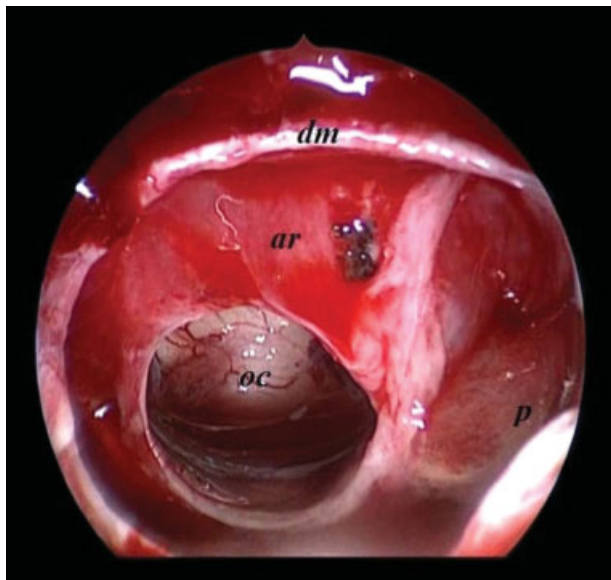
Fig. 6 Endoscopic close-up of a large arachnoidal defect after removal of a macroadenoma. ar, arachnoid; dm, dura mater; oc, optic chiasm; p, pituitary gland.

not require the multilayer closure technique needed for extended approaches. Esposito et al presented a grading of CSF intraoperative leaks, with a related repair strategy according to which "low-grade" CSF leaks can be repaired less invasively, whereas larger defects require more extensive reconstructions.[3] Although we do agree that grade 1 leaks can be duly managed with simple sellar and sphenoid packing (e.g., with autologous fat grafts), nonetheless some transsellar approaches (e.g., for the complete removal of invasive pituitary adenomas) can entail a diaphragm sellae defect comparable with extended approaches (►Figs. 6 and 7). Therefore, we believe that a clear distinction between standard and extended approaches should not dictate the closure technique, which should always be meticulous and reliable. A standardized reconstruction technique might also decrease complications and failures.

In our series of 16 cases, the closure technique with homologous fascia lata never failed. The 12 cases with intraoperative CSF leakage did not experience postoperative rhinoliquorrhea, and the 4 cases operated for rhinoliquorrhea had no leak recurrence. In these last four cases of iatrogenic CSF fistula repair, during the original transsphenoidal surgery sellar reconstruction entailed the use of a fat graft with a
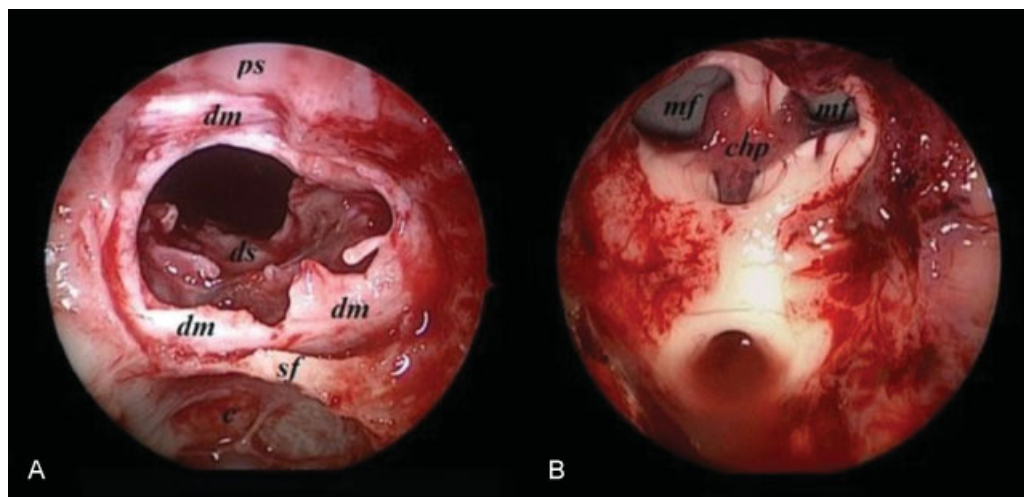
Fig. 7 (A) Endoscopic view of the sella after tumor removal. A large arachnoid defect is visible. (B) The endoscope is advanced into the arachnoid defect, showing third ventricle structures. c, clivus; chp, choroidal plexus; dm, dura mater; ds, dorsum sellae; mf, Monro foramen; ps, planum sphenoidale; sf, sellar floor.

Intraoperatively, when possible we place three layers of fascia lata: intradural, extradural, and extrasellar (►Fig. 5). During the reconstruction of the extradural and extrasellar layers, the fascia lata graft is arranged and laid so the sticky aspect is oriented upward interfacing the dura and the demucosized bone. Similarly, the inner intradural layer is set so the sticky part lies inward in contact with the intrasellar fat graft, which serves as a buttress to keep the fascial graft in place. Such an orientation of the fascia lata layers prevents the contact between the two sticky aspects, thus easing the manipulation and arrangement of the extradural fascial layer, usually the trickiest to place.

Some might argue that the intraoperative finding of CSF leak during standard endoscopic transsphenoidal approaches does

double intra-extradural layer of sphenoidal mucosa in two cases and a single mucoperiosteal layer in one case, and only a fat graft layer in the last case. In all these four cases a fibrin glue seal overlay was always performed. Despite sellar packing with fat graft and the use of fibrin glue, the closure failed. Therefore homologous fascia lata, probably due to its specific characteristics, proved effective in providing a watertight sellar closure when used in combination with autologous fat and fibrin glue, which did not have the same reliability when associated with materials other than fascia lata (i.e., sphenoidal mucosa and mucoperiosteum).

With the limits of our small preliminary series and a retrospective review, sellar repair using homologous fascia lata has always proved effective in terms of clinical outcome.

Conclusion

Fascia lata constitutes a preferred autologous grafting material for reconstruction after endoscopic transsphenoidal surgery. We believe its efficacy, reliability, and safety make banked homologous fascia lata graft a viable alternative to autologous material. In our opinion, an accurate multilayered strategy is the best way to avoid the complication of a CSF leak and represents the correct choice when possible. Higher levels of evidence are needed to assess the actual impact of a banked homologous graft in terms of clinical outcome.

References

1 Cappabianca P, Solari D. Skull base osteo-dural repair: the Achilles' heel of the extended transsphenoidal skull base approaches. World Neurosurg 2010;73(6):627–629

2 Cavallo LM, Messina A, Esposito F, et al. Skull base reconstruction in the extended endoscopic transsphenoidal approach for suprasellar lesions. J Neurosurg 2007;107(4):713–720

3 Esposito F, Dusick JR, Fatemi N, Kelly DF. Graded repair of cranial base defects and cerebrospinal fluid leaks in transsphenoidal surgery. Neurosurgery 2007;60(4, Suppl 2):295–303; discussion 303–304

4 Lund VJ, Stammberger H, Nicolai P, et al; European Rhinologic Society Advisory Board on Endoscopic Techniques in the Management of Nose, Paranasal Sinus and Skull Base Tumours. European position paper on endoscopic management of tumours of the nose, paranasal sinuses and skull base. Rhinol Suppl 2010;22(22):1–143

5 Tomita T, Hayashi N, Okabe M, et al. New dried human amniotic membrane is useful as a substitute for dural repair after skull base surgery. J Neurol Surg B Skull Base 2012;73(5):302–307

6 Marton E, Billeci D, Schiesari E, Longatti P. Transnasal endoscopic repair of cerebrospinal fluid fistulas and encephaloceles: surgical indications and complications. Minim Invasive Neurosurg 2005; 48(3):175–181

7 Eloy JA, Shukla PA, Choudhry OJ, Singh R, Liu JK. Challenges and surgical nuances in reconstruction of large planum sphenoidale tuberculum sellae defects after endoscopic endonasal resection of parasellar skull base tumors. Laryngoscope 2013;123(6): 1353–1360

8 Sciarretta V, Mazzatenta D, Ciarpaglini R, Pasquini E, Farneti G, Frank G. Surgical repair of persisting CSF leaks following standard or extended endoscopic transsphenoidal surgery for pituitary tumor. Minim Invasive Neurosurg 2010;53(2):55–59

9 Cappabianca P, Cavallo LM, Valente V, et al. Sellar repair with fibrin sealant and collagen fleece after endoscopic endonasal transsphenoidal surgery. Surg Neurol 2004;62(3):227–233; discussion 233

10 Wheatcroft SM, Vardy SJ, Tyers AG. Complications of fascia lata harvesting for ptosis surgery. Br J Ophthalmol 1997;81(7):581–583

11 Cappabianca P, Cavallo LM, de Divitiis E. Endoscopic endonasal transsphenoidal surgery. Neurosurgery 2004;55(4):933–940; discussion 940–941

12 Cappabianca P, Esposito F, Cavallo LM, et al. Use of equine collagen foil as dura mater substitute in endoscopic endonasal transsphenoidal surgery. Surg Neurol 2006;65(2):144–148; discussion 149

13 Cavallo LM, Solari D, Somma T, Savic D, Cappabianca P. The awake endoscope-guided sealant technique with fibrin glue in the treatment of postoperative cerebrospinal fluid leak after extended

transsphenoidal surgery: technical note. World Neurosurg 2014; 82(3–4):e479–e485

14 Locatelli D, Rampa F, Acchiardi I, Bignami M, De Bernardi F, Castelnuovo P. Endoscopic endonasal approaches for repair of cerebrospinal fluid leaks: nine-year experience. Neurosurgery 2006;58(4, Suppl 2):ONS-246–ONS-256, ONS-256–ONS-257

15 Cavallo LM, Frank G, Cappabianca P, et al. The endoscopic endonasal approach for the management of craniopharyngiomas: a series of 103 patients. J Neurosurg 2014;121(1):100–113

16 Eloy JA, Patel SK, Shukla PA, Smith ML, Choudhry OJ, Liu JK. Triple-layer reconstruction technique for large cribriform defects after endoscopic endonasal resection of anterior skull base tumors. Int Forum Allergy Rhinol 2013;3(3):204–211

17 Ziu M, Jimenez DF. The history of autologous fat graft use for prevention of cerebrospinal fluid rhinorrhea after transsphenoidal approaches. World Neurosurg 2013;80(5):554–562

18 Ahn JY, Kim SH. A new technique for dural suturing with fascia graft for cerebrospinal fluid leakage in transsphenoidal surgery. Neurosurgery 2009;65(6, Suppl):65–71; discussion 71–72

19 Castelnuovo P, Mauri S, Locatelli D, Emanuelli E, Delù G, Giulio GD. Endoscopic repair of cerebrospinal fluid rhinorrhea: learning from our failures. Am J Rhinol 2001;15(5):333–342

20 Garcia-Navarro V, Anand VK, Schwartz TH. Gasket seal closure for extended endonasal endoscopic skull base surgery: efficacy in a large case series. World Neurosurg 2013;80(5):563–568

21 Gardner P, Kassam A, Snyderman C, Mintz A, Carrau R, Moossy JJ. Endoscopic endonasal suturing of dural reconstruction grafts: a novel application of the U-Clip technology. Technical note. J Neurosurg 2008;108(2):395–400

22 Giovannetti F, Ruggeri A, Buonaccorsi S, Pichierri A, Valentini V. Endoscopic endonasal approaches for cerebrospinal fluid leaks repair. J Craniofac Surg 2013;24(2):548–553

23 Kassam A, Carrau RL, Snyderman CH, Gardner P, Mintz A. Evolution of reconstructive techniques following endoscopic expanded endonasal approaches. Neurosurg Focus 2005;19(1):E8

24 Leng LZ, Brown S, Anand VK, Schwartz TH. "Gasket-seal" water-tight closure in minimal-access endoscopic cranial base surgery. Neurosurgery 2008;62(5, Suppl 2):E342–E343; discussion E343

25 Sabatino G, Della Pepa GM, Bianchi F, et al. Autologous dural substitutes: a prospective study. Clin Neurol Neurosurg 2014; 116:20–23

26 Schmalbach CE, Webb DE, Weitzel EK. Anterior skull base reconstruction: a review of current techniques. Curr Opin Otolaryngol Head Neck Surg 2010;18(4):238–243

27 Hadad G, Bassagasteguy L, Carrau RL, et al. A novel reconstructive technique after endoscopic expanded endonasal approaches: vascular pedicle nasoseptal flap. Laryngoscope 2006;116(10): 1882–1886

28 Horridge M, Jesurasa A, Olubajo F, Mirza S, Sinha S. The use of the nasoseptal flap to reduce the rate of post-operative cerebrospinal fluid leaks following endoscopic trans-sphenoidal surgery for pituitary disease. Br J Neurosurg 2013;27(6):739–741

29 Brown SL, Govier FE. Cadaveric versus autologous fascia lata for the pubovaginal sling: surgical outcome and patient satisfaction. J Urol 2000;164(5):1633–1637

30 Almeida SHM, Gregório EP, Rodrigues MAF, Grando JPS, Moreira HA, Fraga FC. Banked cadaveric fascia lata: 3-year follow-up. Transplant Proc 2004;36(4):993–994

31 Tiengo C, Giatsidis G, Azzena B. Fascia lata allografts as biological mesh in abdominal wall repair: preliminary outcomes from a retrospective case series. Plast Reconstr Surg 2013;132(4): 631e–639e